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A Panel Data Analysis

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Venture Capital Investment and Labor Market Performance: A Panel Data Analysis

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Abstract

Labor market performance has differed considerably between OECD countries over the last two decades. The focus of the literature so far has been to ask whether these differences can be explained by varying degrees of labor market rigidities and generosity of welfare states. This paper takes a different perspective and analyzes whether differences in venture capital investments have explanatory power with respect to labor market performance across countries and over time. In particular, the Anglo-Saxon countries have been relatively successful over the last two decades in producing employment growth and in reducing unemployment compared to most continental European OECD countries. As a rule they have also been and are still ahead in developing thriving venture capital markets that are often deemed crucial for the creation of new firms and for successfully managing the ongoing radical structural change away from traditional industrial production toward the so-called "new economy".

Keywords: labor markets, venture capital, unemployment, new economy, panel analysis

JEL classification: E22, E24, E44, G24, G32

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I. Introduction

The persistent rise in unemployment along with the conspicuous lack of job creation in many continental European countries still begs to be thoroughly explained. Labor market rigidities along with generous welfare states are often considered to be at the root of the European unemployment problem.[1] While it seems by now well established that both factors do indeed matter considerably, it is far from clear that both factors even when taken together constitute a satisfactory explanation on their own. An obvious problem with this approach is the high degree of continuity of these institutions over time so that only a combination of these institutions with adverse shocks is a promising avenue for explaining simultaneously different labor market performances across countries and changes over time. Furthermore, higher rates of job creation in Anglo-Saxon than in continental European countries have not been restricted to low-paid jobs, where labor market rigidities and the generosity of the welfare state matter most. Yet, it is far less evident why these institutional features should also obstruct the creation of high paid jobs. Other structural factors, which impact clearly on the creation of both low and high paid jobs, might therefore have to be considered as well.

Economic intuition suggests that job creation over the whole wage spectrum should not only be related to real wage costs and their flexibility in the face of shocks but also to economic growth and in particular to investments. A possible and hitherto underexplored structural factor in explaining labor market performance differences across countries and changes over time are therefore capital market institutions which might affect the ability of economies to invest especially in risky and new ventures.[2] This type of investment appears to be crucial though for job creation in the ongoing period of radical structural change away from traditional industrial production toward the so-called "new economy", in which new jobs are rarely created by the expansion of large and established firms such as General Motors, Daimler Benz, IBM or Siemens.

A prime suspect in the realm of capital market institutions are the degree to which venture capital markets are well developed and flourishing. The US especially has benefited from a fully-fledged venture capital market. A number of studies document the ability of US venture capitalists to select promising companies, provide adequate financing and spur innovative firms to behave aggressively and emerge as market leaders.[3] This helped the US to steam

[1] See especially Siebert (1997).
[2] Fazzari, Hubbard and Petersen (1998) and Hubbard (1998) show that financing constraints do indeed matter for corporate investments and that this is especially the case for risky and new ventures.
[3] See e.g. Hellmann and Puri (2000), Kortum and Lerner (1998) and Gompers and Lerner (2001).

ahead in terms of competitiveness and growth during a time period when innovative change has been the cornerstone of entrepreneurial success. Although venture capital financed investments relative to GDP are only a rough measure for the functioning of venture capital markets, this measure has the advantage of being available for a wide range of countries since the mid 1980s. Clearly, lack of venture capital financed investments is not necessarily only due to a lack of supply of venture capital as was for example suspected by the European Commission some time ago[4], but can just as well be due to a lack of experienced venture capitalists or due to a demand problem possibly caused by a lack of innovative entrepreneurs asking for venture capital finance. Total measured venture capital investments obviously reflect both supply and demand for venture capital, and thus the overall functioning of the venture capital market. However, a potential problem in using venture capital investments as a right hand side variable for empirically explaining labor market performance is their possible endogeneity, i.e., venture capital investments themselves are not exogenous but rather depend on GDP growth and institutional factors such as the possibility for the venture capitalist to exit the engagement via an initial public offering. We will account for this potential endogeneity problem in our empirical estimations.

It is noteworthy that not all types of venture capital investments are equally likely to lead to job creation. So called “early stage investments” are especially promising in this respect because they serve to set up a new firm with possibly new and innovative ideas. Management buy-outs where corporate insiders in established firms seek venture capital to take control of their firm appear to be less promising for creating positive employment effects in comparison. Interestingly, the former type of investment has until 1998 been much more prevalent in the US compared to continental Europe, where the latter type of investment constitutes a larger share of total venture capital investment. Hence, not only the total level of venture capital investments but also their structure appears to be less conducive to job creation in continental Europe compared to the US. This assessment is reinforced by the fact that banks and governments are major providers of venture capital in continental Europe, both of which are unlikely candidates for identifying the types of highly risky investments, which make most sense from a purely economic point of view. Finally, the two greatest shares of venture capital investments in continental Europe are devoted to manufacturing and to consumer industry, whereas in the US venture capital investments are predominantly in the computer, telecommunications and biomedical industry. Hence, not only the level but also the structure

[4] See European Commission (1998).

of venture capital investments in the US appears to be more conducive to job creation from this sectoral perspective.[5]

Given the fact that European capital markets are traditionally bank-dominated[6], it seems natural to ask why banks in Europe should not be able to play the role that venture capitalists are fulfilling in the US and other Anglo-Saxon countries. In other words, why do banks typically refrain from financing start-ups? This could be due to the fact that banks are hardly suitable financiers for this type of risky project. Raising deposits from the public at large usually finances bank lending and banks earn profits in this part of their business activities due to interest rate margins between credits and deposits. The generally high liquidity of deposits creates pressure on banks to engage predominantly in relatively liquid credit contracts. Hence, banks need debtor firms which are able to pay them back within a reasonably short time period and with a high probability and/or which can provide them with ample collateral, i.e., tangible assets such as property and buildings. These requirements can hardly be met by start-up firms, which are as a rule highly risky, have no positive cash flows for some time even in the case that they are fundamentally successful and which invest a large part of their acquired capital in intangible assets such as software and human capital which cannot serve well as collateral. Three additional reasons deserve to be mentioned why banks cannot act as perfect substitutes for US-style venture capitalists. First, the traditionally close ties between banks and established large industrial firms in a country such as Germany make banks less aggressive in nourishing possible future competitors of established firms. Second, due to the fact that the stability of the banking system is a politically sensitive issue, government regulations result in banks facing severe legal restrictions concerning the financing of risky investments such as start-ups. Third, banks hardly possess the sector- and firm-specific knowledge of US-style venture capitalists that is necessary to help young firms in managing the especially risky start-up and expansion phase.

The rest of the paper is organized as follows. Section Two briefly summarizes the main results of a recent theoretical paper by Acemoglu (2001) which reflects our intuitive reasoning. The Third section is the innovative heart of the paper as it provides a detailed empirical panel data analysis for the conjectured effect of venture capital investments on labor market performance. The final section sums up the results and presents some conclusions for economic policy.

[5] See Bottazzi and Da Rin (2001).
[6] See e.g. Edwards and Fischer (1994).

II. The model

Acemoglu (2001) has recently proposed a simple but highly plausible formal model where differences in the ability of economies to channel external funds to new firms plays a key role in explaining why some economies experience an extended phase of depressed job creation and persistent unemployment in the wake of the arrival of a new set of technologies while other economies can adapt much faster to such a technological shock and largely avoid unemployment problems.[7] Better functioning venture capital markets in Anglo-Saxon countries in general and in the US in particular compared to continental Europe may reflect this difference in the ability to channel external funds quickly and smoothly to promising new entrepreneurs. Steady-state unemployment such as in the 1960s need not differ by much between the two types of economies in such an institutional setting because entrepreneurs with promising and innovative ideas will eventually obtain funds possibly even through their own savings or via loans from the extended family. However, in the medium run the failure of rigid capital markets with badly functioning venture capital markets to provide quick external financing to those entrepreneurs who are most promising after a technological shock leads to an extended phase of depressed job creation and a persistent rise in unemployment because job destruction in declining sectors cannot be prevented. Hence, according to this model a direct effect of the functioning of venture capital markets on labor market performance can be expected in a period of rapid structural change because employment creation depends on the creation of new firms in the expanding sectors which in turn can only occur on a large scale and sufficiently quickly if adequate channels of financing such as via venture capital are available. This fits well with an influential paper by Blanchard (1997) in which he labels structural unemployment in continental Europe as a medium run phenomenon in the aftermath of severe shocks. Interestingly, the malaise on the labor market is in some respect self-reinforcing in Acemoglu's model because higher unemployment in economies with rigid capital markets leads to lower real wages and thus also to lower savings of workers which prolongs the time until a worker with post-technology shock entrepreneurial ideas can start his own business based on his own savings.

However, structural unemployment can only exist if there also exists at least some basic rigidity on the labor market. This result holds even under an institutional setting with highly rigid capital markets because infinite real wage flexibility would always clear the labor

[7] Two other important models with similar results, namely that credit market imperfections exacerbate structural unemployment caused by rigid labor markets, have been suggested by Caballero and Hammour (1999) and by Wasmer and Weil (2000).

market if labor markets were perfectly flexible no matter how small labor demand is due to financing restrictions. To avoid this problem, Acemoglu (2001) assumes an efficiency wage setup that prevents instantaneous labor market clearing via adjustments of real wages. While efficiency wage problems seem to have indeed become more important with the arrival of the "new economy" and with the ongoing reorganization of firms towards holistic instead of Tayloristic production structures[8], it appears that unions, insider-outsider problems and generous welfare states are still at least as critical in making continental European labor markets relatively rigid compared to for example the US. The combination of both, rigid labor markets and capital market institutions which do not fit well with a period of rapid structural change, can therefore be expected to be harmful to labor market performance because the quasi-equilibrium employment rate is then restricted from both sides, via more aggressive wage setting due to labor market rigidities and via depressed labor demand due to an obsolete institutional setting on the capital market. Hence, the quasi-equilibrium unemployment rate is higher, the less well the venture capital market works, given the level of labor market rigidities.

Essentially all recent contributions to this still fledgling literature on the relationship between imperfect capital markets and labor market performance lack convincing empirical evidence for the point they are trying to make, i.e., that capital-market imperfections matter for the level and evolution of employment and of the rate of structural unemployment.[9] The ensuing section is trying to close at least somewhat this gap in the existing literature via a macroeconomic panel data analysis. The hypothesis for the empirical analysis is straightforward. It is conjectured that greater venture capital investments relative to GDP give rise to more employment and a lower level of structural unemployment in a cross-country panel analysis for the 1980s and 1990s when structural change has indeed been rapid not least due to globalization. This positive effect of venture capital investments relative to GDP on labor market performance should occur even when controlling for the key institutional variables on the labor market because it is a direct effect of financing restrictions on labor demand which would only have no employment effect at all if one assumed unrealistically that the short-run wage setting curve were perpendicular implying counterfactually perfectly flexible real wages even in the short run.

[8] See Lindbeck and Snower (2000).
[9] See Caballero and Hammour (1999), Wasmer and Weil (2000) and Acemoglu (2001).

III. Empirical Estimation

1. Empirical model and estimation procedure

In this section we estimate the direct impact of variables measuring venture capital on both employment and unemployment. The model is estimated using panel data on a sample of 20 OECD countries over the period 1987 – 1999. In order to test empirically for the conjectured impact of capital-market institutions and especially venture capital on labor market performance we employ a panel of twenty OECD countries, namely Austria (AUS), Belgium (BEL), Denmark (DEN), Finland (FIN), France (FRA), Germany (GER), Ireland (IRE), Italy (ITA), Netherlands (NET), Norway (NOR), Portugal (POR), Spain (SPA), Sweden (SWE), Switzerland (SWI), United Kingdom (UK), Canada (CAN), United States (USA), Japan (JAP), Australia (AUL), and New Zealand (NEW).

The basic model we wish to estimate is the following,

$$y_{it} = \alpha VC_{it} + \beta GDP_{it} + \delta_j X_{jit} + \varepsilon_{it}, \qquad \textbf{(1)}$$

where y_{it} is the dependent macroeconomic variable for country i in period t (either the unemployment rate or an index of total employment), VC_{it} is our measure of venture capital for country i in period t, GDP is the level of real gross domestic product for country i in period t, included as a cyclical control variable following Wasmer and Weil (2000) and X_{jit} is a vector of j additional variables used to control for key institutional variables. In order to avoid any *ad-hoc* empirical set-up we strictly stick to the main theoretical argument developed in section II and just add capital market variables separately to the list of explanatory variables.

The above model is static in nature. Especially in the case of labor market variables, there are reasons to believe that such a model may be dynamically mis-specified. We therefore specify a second estimating equation:

$$y_{it} = \gamma y_{t-1} + \alpha VC_{it} + \beta GDP_{it} + \delta_j X_{jit} + \varepsilon_{it}, \qquad \textbf{(2)}$$

where y_{t-1} are lags of the dependent variable. This has the appeal that it models either employment or unemployment in a dynamic context and as such venture capital can have both a short-run and a long-run impact.

Dynamic panel models such as that in equation 2 are characterized by the presence of a lagged dependent variable. The major problem that arises when introducing a lagged dependent variable as an explanatory variable is that the error term and the lagged dependent

variable are correlated, with the lagged dependent variable being correlated with the individual specific effects that are subsumed into the error term. This implies that OLS and GLS are biased. As such an alternative method of estimating such models is required.

One proposed solution that removes the individual specific effect is to first difference equation 2. This removes the correlation between the lagged dependent variable and the error term from equation 2, but the transformed error term and the differenced dependent variable, Δy_{it}, are now correlated (see Nickell, 1981). A solution to this problem however is to use instrumental variable (IV) techniques. Anderson and Hsiao (1981) suggest first differencing the model to remove the individual specific effects, and using $\Delta y_{i,t-2} = (y_{i,t-2} - y_{i,t-3})$ or $y_{i,t-2}$ as instruments for $\Delta y_{i,t-1}$. These instruments are correlated to $\Delta y_{i,t-1}$, but will not be correlated with $\Delta u_{it} = (u_{it} - u_{i,t-1})$, as long as the u_{it} are not serially correlated. This IV technique will lead to consistent but not necessarily efficient estimates of the parameters in the model because it does not make use of all the available moment conditions[10] (see Ahn and Schmidt, 1995). The estimator that uses the lagged level as an instrument, $y_{i,t-2}$, rather than the lagged difference, $\Delta y_{i,t-2}$, is recommended by Arellano (1989) who finds it to be more efficient. Moreover, instrumenting with the lagged level has the advantage over using the lagged difference, that only two time periods are lost rather than at least three. Arellano and Bond (1991) propose an extension of Anderson and Hsiao (1981), which utilizes the General Methods of Moments (GMM) procedure to accommodate the inclusion of further lagged variables as additional instruments. Additional instruments can be obtained by utilizing the available orthogonality conditions that exist between the lagged values of the dependent variable and the errors. Thus the further advanced the panel, the greater the number of instruments available. The advantage of this procedure is that it allows both the cross-section and the time-series elements of the data to be exploited when constructing valid instruments. The validity of this approach requires a lack of second order serial correlation in the dynamic specification, so tests for this are presented with the results. Overall instrument validity is also examined using a Sargan test[11] of over identifying restrictions. The null hypothesis of the Sargan test is of the exogeneity of the instrument set.

We consider a similar specification for both the static and dynamic model. Given the above discussion therefore, the final estimating equations we employ are:

[10] Moment conditions are conditions on the covariances between regressors and the error term. Regressors may be orthogonal to the error term, in which case we can use orthogonality conditions, that the covariance between the regressors and the error term is zero.
[11] Following Sargan (1958).

$$\Delta y_{it} = \alpha \Delta VC_{it} + \beta \Delta GDP_{it} + \delta_j X_{jit} + \Delta \varepsilon_{it}, \quad \textbf{(3)}$$

and

$$\Delta y_{it} = \gamma y_{t-1} + \alpha \Delta VC_{it} + \beta \Delta GDP_{it} + \delta_j X_{jit} + \Delta \varepsilon_{it}, \quad \textbf{(4)}$$

where Δ refers to the first difference of the variable in question. By taking first differences from most of our variables, we use a consistent model. One thing to note from these equations however is that the additional variables accounting for institutional variables are included in levels rather than differences, these are included in levels since they show little variation across time.

Turning to the data used in estimating equations 3 and 4, the appendix at the end of the paper describes the variables and provides details about the sources of the data. The sample of data runs from 1986 to 1999, but because of first differencing we lose one observation, meaning that the dataset runs from 1987 to 1999.

The dependent variable in the models estimated is either the first difference of the unemployment rate (*DUNEMP*) or of the index of employment (*DEMP*). In addition to using both employment and unemployment as dependent variables we also sequentially use two measures of venture capital, these being either the first difference of venture capital (*DVC*) or early stage venture capital (*DINVEARLY*). *DVC* is defined as the seed, start-up and expansion (both government and private sector funded) as per million of average GDP, while *DINVEARLY* is used to account for early stage venture capital only, and is defined as the seed and start-up (both government and private sector funded) as per million of average GDP. There is good reason to believe that these variables measuring venture capital may be endogenous. This is not only valid with respect to the labor market variables but also to another independent variable, namely real GDP that is used as a cyclical control variable in our context. Hence, in the case of a significant coefficient of venture capital, one could argue that the demand for finance has been strong and the supply of venture capital supply has been stimulated in those countries that have been innovative and able to create jobs (strong employment growth) and where the macroeconomic climate has been favorable and macroeconomic policy has been supportive[12]. In this case, both employment and venture capital investment may then be driven by a third factor. Estimated coefficients of venture

[12] Given that labor market institutions are often badly measured, an alternative view would be that venture capital may capture their effects.

capital might then be biased. Hence, to account for the problem of endogeneity of the venture capital variable and thus for possible reverse causality we instrument the venture capital variables, employing lags of the variables two periods earlier as instruments.

The additional variables in the model are included to control for key institutional characteristics. Firstly, we include variables to control for various institutional labor market variables. As such, we include a measure of the benefit replacement ratio (*RR1*), a measure of the duration of unemployment benefits (*Benefit*), a measure of employment protection (*Empro*), the tax wedge (*Wedge*) and a measure of the centralization of wage bargaining (*Uncord*). These it is expected will adequately control for factors that contribute towards labor market rigidities, which include high firing costs, strong unions and generous employment benefits. Secondly, we include a variable to account for the presence of institutional capital markets, by including an index of the legal system's protection of creditors in case of a firm's liquidation or re-organization (*CreditRight*). This variable reflects the legal position of creditors vis-à-vis firms in the case of financial distress.[13].

With respect to the sign on the coefficients of these additional variables included in our regressions, we expect the following marginal coefficients for the unemployment equations (and vice versa for the employment equations; question marks represent ambiguous cases)[14]. We expect *RR1, Benefit, Empro* and *Wedge* to be positive, while the coefficients on *Uncord* and *CreditRight* are expected to be negative. At the same time we expect that the coefficients on the changes in the two venture capital variables (*DVC* and *DINVEARLY*) would be negative, such that an increase in venture capital availability would reduce the unemployment rate.

2. Results

In order to convey a broad-brush view on the data set and some of the possible correlations four scatter plots are presented below. These show plots of our measure of the change in the unemployment rate (*DUNEMP*) and the change in our index of employment (*DEMP*) against

[13] Finally, in a number of specifications we also included a set of country dummies, *Englaw*, *Frelaw* and *Gerlaw*, which are dummy variables taking the value 1 if the country follows English, French or German law respectively. The remaining group is Scandinavian law countries. In addition, we let the country law dummy variables interact with either the first differenced value of *VC* (**dvc*) and *Invearly* (**DINVEARLY*) or the level of *VC* (**vc*) and *Invearly* (**inv*). However, the results turned out to be insignificant in the overwhelming number of cases. The justification for additionally including them was to let the impact of venture capital on labor markets depend on labor market flexibility. However, in this paper we argue for a direct effect of venture capital on labor market performance.

[14] See, e.g., Blanchard and Wolfers (1999), and Layard and Nickell (1997).

the change in venture capital investment (*DVC*) and the change in early stage venture capital investment (*DINVEARLY*). All variables are averaged for each country over the period for which we have data for them, which lies somewhere in the region between 1986 and 1999.

Figure 1: Change in Unemployment against the Change in Venture Capital

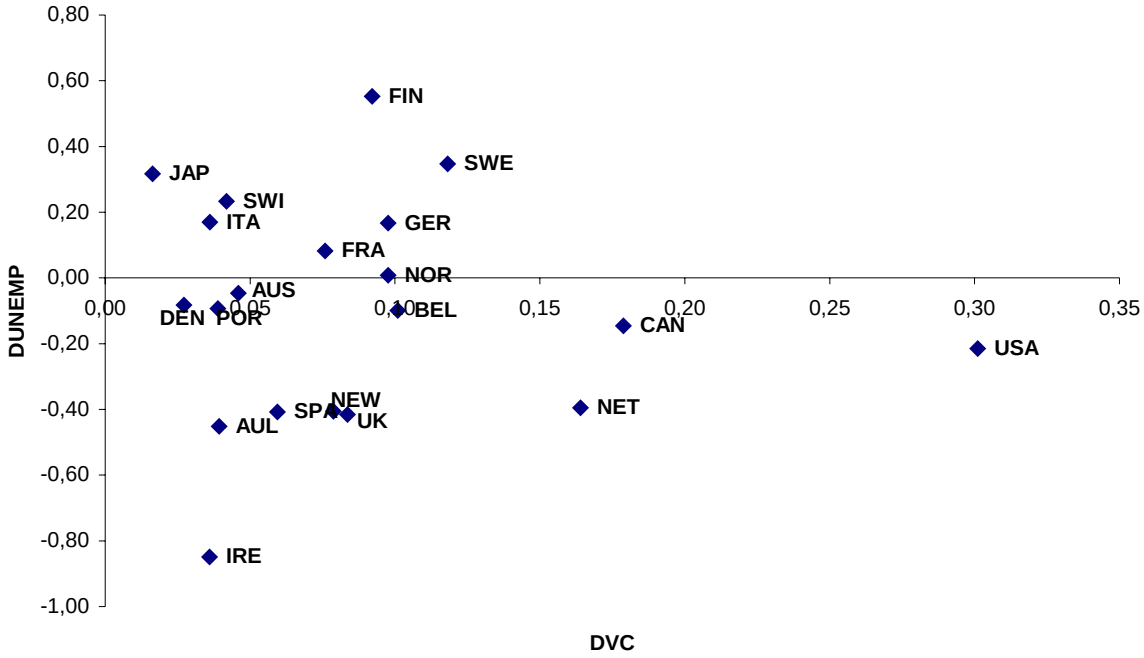


Figure 2: Change in Unemployment against the Change in Early Stage Venture Capital

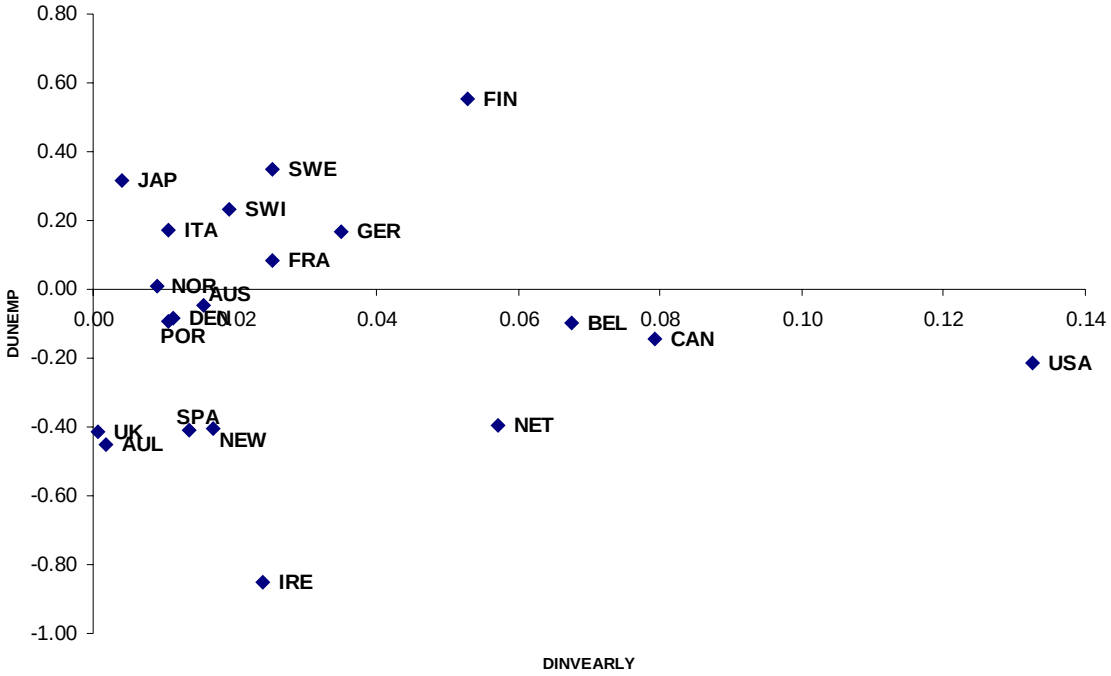


Figure 3: Change in Employment against the Change in Venture Capital

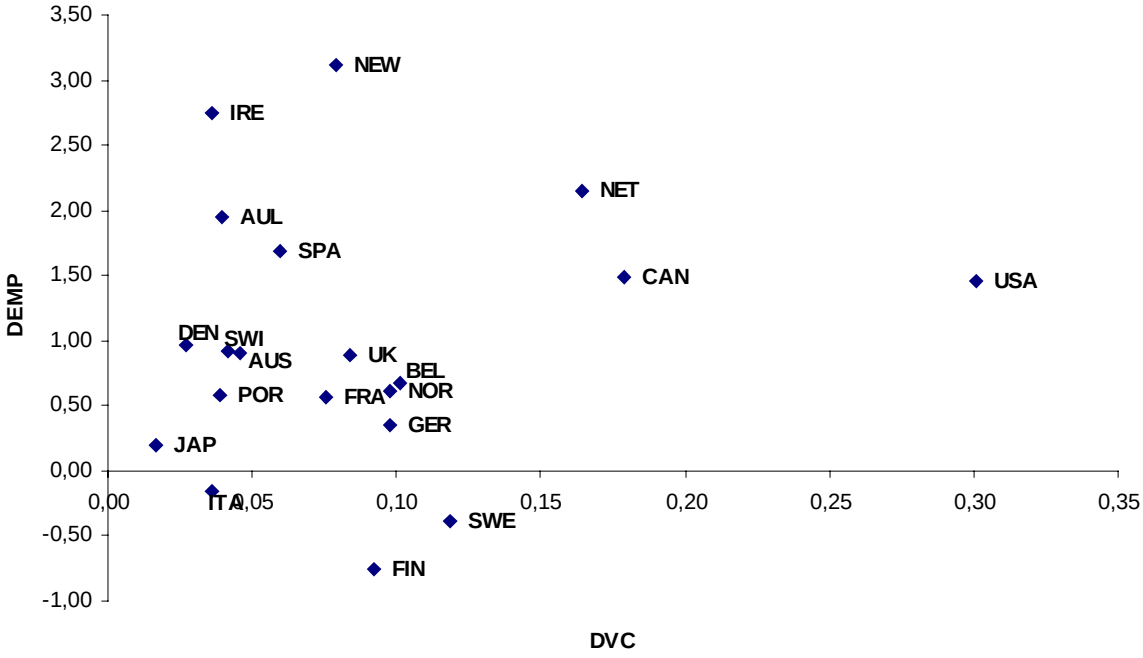
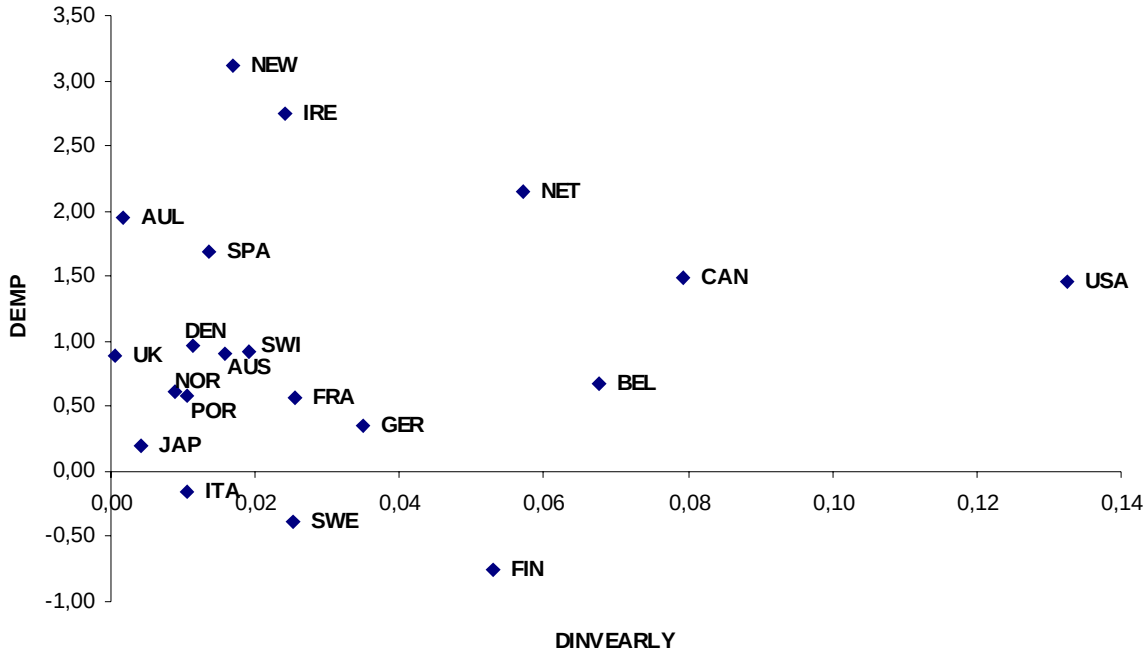


Figure 4: Change in Employment against the Change in Early Stage Venture Capital



Based on a visual inspection of the scatter plots, a negative relationship between the availability of (early stage) venture capital and changes in unemployment and a positive one with respect to changes in employment cannot be excluded ex ante. However, any premature and far-reaching conclusions are based on shaky grounds at this stage of our analysis in view of potential problems of simultaneity between the respective indicator of labor market performance and the VC variable. We have already extensively addressed this problem in this section. Hence, we dispense with estimating a regression line within the scatter plots which would insinuate a causal relationship with VC as the independent variable.

We started our formal empirical analysis with tests of the non-stationarity of the levels and the first differences of the variables under consideration. The test we applied was the first widely used panel data unit root test by Levin and Lin (1992). The results, which are available on request, reveal that in many cases the levels of the variables are non-stationary, but that the changes in these variables, which we employ here, are indeed stationary.

Based on our theoretical arguments, we conjecture that controlling for the key institutional variables on the labor and the capital market, venture capital improves labor-market performance in a cross-country panel analysis. To test for a significant relationship between venture capital and labor-market performance, we undertake estimations in differences and for early stage as well as for total venture capital investment. The models were estimated using the package Dynamic Panel Data 98 for GAUSS, details of which are provided by

Arellano and Bond (1998). The following Tables display the results from estimating equations 3 and 4. The tables report the coefficient along with heteroscedastic consistent t-ratios. The validity of the dynamic models depends upon a lack of second order serial correlation and the validity of the instrument set (Sargan test). Results of these tests are reported in the tables.

Table 1: The Impact of *DVC* on Changes in Unemployment

DUnemp	*1*	*2*	*3*	*4*	*5*	*6*
DUnemp-1				0.51	0.5	0.51
				(11.22)***	(12.77)***	(10.34)***
DUnemp-2				-0.24	-0.52	-0.22
				(-3.35)***	(-2.54)**	(-2.97)***
DUnemp-3				0.05		0.05
				(0.89)		(0.92)
DUnemp-4				-0.13		-0.11
				(-2.4)**		(-2.03)**
DVC	-0.84	0.87	-0.31	-0.37	-0.52	-0.33
	(-1.87)*	(0.57)	(-0.35)	(-1.81)*	(-2.54)**	(-1.64)*
DGDP	-0.33		-0.38	-0.26		-0.28
	(-1.79)*		(-2.24)**	(-6.84)***		(-6.7)***
RR1		0.006	0.006		0.0	-0.002
		(0.17)	(0.2)		(0.02)	(-0.34)
Benefit		-0.1	0.39		-0.21	0.01
		(-0.15)	(0.71)		(1.81)*	(0.09)
Uncord		0.16	0.94		-0.18	0.04
		(0.18)	(1.41)		(-1.37)	(0.29)
Empro		0.13	-0.06		0.03	0.003
		(1.1)	(-0.74)		(1.23)	(0.15)
Wedge		-0.004	0.03		-0.02	-0.01
		(-0.05)	(0.4)		(-1.16)	(-1.25)
CreditRight		-0.74	-0.15		0.13	-0.14
		(-0.8)	(-0.51)		(0.82)	(-1.06)
Constant	0.89	-0.45	-2.46	0.71	1.34	1.67
	(2.18)**	(-0.1)	(-0.65)	(8.69)***	(1.52)	(2.87)***
Wald	11.74***	3.78	10.9	176.36***	271.2***	430.96***
1st Order Serial Correlation	2.3**	2.2**	1.37	0.05	1.88*	1.1
2nd Order Serial Correlation	-0.16	1.68*	0.77	0.71	-0.65	1.58
Sargan Test	5.63	2.74	0.63	55.89	76.74	45.66

Note: All models are estimated using robust standard errors. Values in parentheses are t-statistics. ***, **, * indicate significance at the 1, 5 and 10 percent levels respectively.

Table 2: The Impact of *DINVEARLY* on Changes in Unemployment

DUnemp	*1*	*2*	*3*	*4*	*5*	*6*
DUnemp-1				0.39	0.71	0.41
				(6.53)***	(10.55)***	(5.85)***
DUnemp-2					-0.3	
					(-5.11)***	
DINVEARLY	-1.65	1.46	0.99	-0.2	-0.75	-0.25
	(-1.49)	(0.37)	(0.28)	(-0.4)	(-1.13)	(-0.5)
DGDP	-0.43		-0.12	-0.3		-0.33
	(-4.05)***		(-0.36)	(-5.62)***		(-8.12)***
RR1		-0.08	-0.06		0.001	-0.005
		(-0.9)	(-1.17)		(0.07)	(-0.55)
Benefit		-0.26	-0.2		-0.23	0.05
		(-0.35)	(-0.29)		(-2.16)**	(0.57)
Uncord		0.21	0.19		-0.26	0.1
		(0.12)	(0.14)		(-2.0)**	(0.63)
Empro		0.17	0.14		0.04	0.01
		(1.25)	(0.93)		(1.79)*	(0.46)
Wedge		-0.07	-0.07		-0.02	-0.03
		(-0.69)	(-0.78)		(-0.97)	(-1.99)*
CreditRight		-0.04	0.02		0.17	-0.2
		(-0.03)	(0.02)		(1.19)	(-1.56)
Constant	1.1	5.85	5.32	0.72	1.04	2.52
	(3.84)***	(1.0)	(1.06)	(6.93)***	(1.37)	(3.59)***
Wald	16.66***	5.83	10.16	61.0***	382.9***	299.04***
1st Order Serial Correlation	2.26**	1.66*	1.64	1.42	0.51	1.93*
2nd Order Serial Correlation	0.44	1.39	1.42	0.03	0.98	1.52
Sargan Test	5.22	0.53	0.68	63.01	77.3	42.06

Note: All models are estimated using robust standard errors. Values in parentheses are t-statistics. ***, **, * indicate significance at the 1, 5 and 10 percent levels respectively.

Table 3: The Impact of *DVC* on Changes in Employment

DEmp	*1*	*2*	*3*	*4*	*5*	*6*
DEmp-1				0.43	0.55	0.42
				(6.68)***	(5.18)***	(6.05)***
DEmp-2					-0.14	
					(-1.61)	
DEmp-3					-0.04	
					(-0.75)	
DEmp-4					-0.13	
					(-3.21)***	
DVC	2.96	1.36	2.77	0.64	0.88	0.78
	(1.79)*	(0.52)	(1.09)	(2.03)**	(2.29)**	(2.29)**
DGDP	0.46		0.46	0.44		0.47
	(1.39)		(1.7)*	(7.41)***		(5.6)***
RR1		-0.15	-0.15		0.002	0.01
		(-1.08)	(-1.1)		(0.2)	(1.59)
Benefit		-0.03	-0.6		0.31	-0.1
		(-0.02)	(-0.81)		(1.81)*	(-1.14)
Uncord		2.63	1.72		0.5	-0.14
		(0.98)	(0.71)		(1.25)	(-0.73)
Empro		-0.22	0.02		-0.04	0.04
		(-0.94)	(0.12)		(-0.93)	(1.14)
Wedge		0.06	0.02		-0.05	-0.02
		(0.48)	(0.22)		(-1.7)*	(-0.91)
CreditRight		0.01	-0.69		0.05	0.12
		(0.01)	(-0.54)		(0.18)	(0.7)
Constant	-0.62	2.72	5.11	-0.68	1.48	-0.71
	(-0.89)	(0.31)	(0.84)	(-4.69)***	(1.24)	(-0.82)
Wald	8.4**	8.29	27.08***	132.99***	437.07***	609.74***
1st Order Serial Correlation	2.14**	1.81***	1.45	0.34	1.11	0.25
2nd Order Serial Correlation	1.48	1.5	1.19	-0.31	0.15	-0.26
Sargan Test	6.78	1.48	0.95	62.69	71.54	56.79

Note: All models are estimated using robust standard errors. Values in parentheses are t-statistics. ***, **, * indicate significance at the 1, 5 and 10 percent levels respectively.

Table 4: The Impact of *DINVEARLY* on Changes in Employment

DEmp	*1*	*2*	*3*	*4*	*5*	*6*
DEmp-1				0.41	0.61	0.41
				(5.92)***	(6.33)***	(3.56)***
DEmp-2					-0.15	0.001
					(-1.74)*	(0.02)
DINVEARLY	4.57	-3.61	-0.56	2.04	2.34	2.37
	(1.94)*	(-0.7)	(-0.12)	(1.64)*	(1.66)*	(1.83)*
DGDP	0.78		0.76	0.47		0.51
	(3.58)***		(1.02)	(10.46)***		(7.73)***
RR1		0.07	-0.03		0.02	0.01
		(0.62)	(-0.22)		(1.57)	(1.27)
Benefit		0.85	0.42		0.1	-0.22
		(0.63)	(0.39)		(0.77)	(-2.48)**
Uncord		-2.17	-2.07		0.46	-0.17
		(-0.6)	(-1.25)		(1.19)	(-0.78)
Empro		-0.4	-0.2		-0.06	0.03
		(-2.02)**	(-0.9)		(-1.39)	(0.98)
Wedge		0.19	0.17		-0.02	-0.01
		(0.97)	(0.95)		(-0.94)	(-0.58)
CreditRight		1.1	0.69		-0.39	0.05
		(0.34)	(0.25)		(-1.49)	(0.26)
Constant	-1.31	-7.63	-4.16	-0.76	0.6	-0.63
	(-2.11)**	(-0.88)	(-0.55)	(-3.66)***	(0.81)	(-0.82)
Wald	12.81***	9.08	56.57***	128.48***	167.29***	980.63***
1st Order Serial Correlation	1.86*	2.05**	1.99**	0.57	1.14	0.66
2nd Order Serial Correlation	0.74	1.94*	1.61	-0.57	0.55	-0.42
Sargan Test	13.1	2.05	2.65	61.55	72.6	53.36

Note: All models are estimated using robust standard errors. Values in parentheses are t-statistics. ***, **, * indicate significance at the 1, 5 and 10 percent levels respectively.

3. Results

To start with, note that the Sargan test for the validity of the instruments is always insignificant and that the test of second order serial correlation is insignificant in the dynamic model, suggesting that the models are well specified. Furthermore, if we examine the coefficients on the additional variables included in the model, the coefficient on the change in GDP is negative when the change in unemployment is the dependent variable and positive when the change in employment is the dependent variable, as expected. Moreover the coefficients of GDP tend to be significant. The coefficients on the institutional variables included in the models tend to be very small and in only a few cases are they significant. In addition to a lack of significance, in many cases the coefficients are not of the expected sign. These results are likely to reflect a number of concerns with the data on these variables. Firstly, we may expect a great deal of multicollinearity between these variables and the results are indicative of such a problem, characterized by insignificant coefficients and coefficients that are not of the expected sign. Secondly, the lack of consistent and significant results on these additional variables may reflect the fact that they show little variation over time. Given that our data has a significant time-series dimension to it, we would expect that the coefficients on these variables would not be as significant as in a cross-section regression for example, where only the cross-country and not the time-series variation would be important. Although these problems are likely to be important, it needs to be kept in mind that these are not the variables of primary interest in this paper and that they are included largely as a test of robustness on the variable of interest here, namely venture capital.

Although the institutional variables do tend to be insignificant, there are a number of cases in which one or more of these variables are significant. In Table 1, *Benefit* is negative and significant in Column 5, which is not the expected sign. In Table 2 we find more evidence of a significant impact of the institutional variables on the change in unemployment, with *Benefit*, *Uncord* and *Wedge* all being negative and significant in at least one case, although the coefficient on *Uncord* is the only variable with the expected sign. *Empro* is also found to be significant and with the expected positive sign in one case. In Table 3, *Benefit* and *Wedge* are significant at the 10 percent level in Column 5, the coefficients being positive, which was not expected, and negative, as expected, respectively. In Table 4, *Benefit* is once again found to be significant in one case, with the coefficient being negative as anticipated. *Empro* is also significant in one case and negative as expected.

Finally, we can concentrate on the variables representing venture capital. Table 1 examines the impact of the change in venture capital on the change in unemployment. The coefficients

on *DVC* tend to be negative as expected (except for Column 2), and in the majority of cases they are also significant at least at the 10 percent level. The results of the dynamic model are more supportive of a significant impact of *DVC* on the change in unemployment than the static results. Table 2 reports the results when *DVC* is replaced by *DINVEARLY*, in order to examine the impact of early stage venture capital on the change in the unemployment rate. The coefficients on *DINVEARLY* are not as supportive of an impact of venture capital on the change in unemployment as those reported in the previous table. The coefficient is of variable sign and never significant at standard levels of significance.

Tables 3 and 4 report the results from examining the impact of venture capital on the change in employment. Table 3 considers the results of including *DVC* as an explanatory variable in the model of employment, while Table 4 reports the results from replacing *DVC* with *DINVEARLY*. The results on *DVC* suggest that it has a positive impact on the change in employment, as hypothesized, with the coefficient usually being significant. The results from the dynamic model give us stronger results concerning the impact of venture capital on employment, with the coefficient always being significant at the 5 percent level. The coefficients on *DINVEARLY* have a variable sign in the static model, with the coefficient being negative in two of the three cases. For the dynamic model and for the remaining static case however, the coefficient is positive as expected, and significant at the 10 percent level.

Seen on the whole, we would argue that our empirical results produce evidence in favor of our central hypothesis, namely that venture capital investment does improve labor market performance, i.e., that it tends to reduce unemployment and to raise employment. However, our empirical results are not equally strong for all model specifications. The strongest results are obtained for the change in total venture capital investment *DVC* within the dynamic model specification. The coefficients are always significant at least at the 10 percent level and exhibit the expected sign in all six cases, thus pointing to a non-negligible impact of *DVC* on both the change in unemployment and on the change in employment. Our results are neither quite as strong for *DINVEARLY* (which does not include expansion investment) nor for the static results. *DINVEARLY* exerts a significant positive impact on the change in employment in one of the three static specifications and in all three dynamic specifications at the 10 percent level in Table 4, but no significant impact of *DINVEARLY* on the change in unemployment could be detected in Table 2. The static model produces correctly signed and significant results only when the institutional variables are left out (Column 1). The coefficient of the venture capital variable *DVC* or *DINVEARLY* exhibits the expected sign in all four tables in Column 1 and is significant at the 10 percent level in three out of the four

cases. Whenever the institutional variables are included in the static model specification (columns 2 and 3), the coefficients of the venture capital variable *DVC* and *DINVEARLY* become insignificant, which might be due to the aforementioned multicollinearity and measurement problems inflicting these institutional variables.

In sum, our empirical results indicate that the positive effect of venture capital investment on labor market performance is more dynamic than static in nature possibly due to a time-to-build period, i.e., it takes time until venture capital investments have realized their full employment potential via feed-back and trickle down-effects on other firms. These other non-venture-capital backed firms might benefit, e.g., as suppliers or customers from the venture-capital backed firms or they improve their products or production processes based on new ideas of the usually more innovative venture-capital backed firms.[15] If so, the full positive effect on labor market performance of the venture capital boom in the 1990s in many countries might actually be realized with some delay during this first decade of the new millennium. Somewhat surprising is the complete lack of any significant impact of *DINVEARLY* on the change in unemployment in Table 2. We suspect that this might be due to a combination of the time-to build effect, which favors the inclusion of expansion investment in the estimations, and labor supply moving in parallel to the overall economic development and thus also venture capital investments. This should be one factor making the measured effect of both types of venture capital investment on employment more pronounced than on unemployment, a difference which also shows up when comparing the impact of *DVC* on the change in unemployment in Table 1 and on the change in employment in Table 3.

4. Long-run effects

Based on our dynamic results, it is finally possible to estimate the long-run contribution of venture capital on un(employment), using the formula $\sum \beta_i /(1-\sum \alpha_i)$, where β_i are the coefficients on the venture capital variables and α_i are the coefficients on the lagged dependent variables. The long-run effect of venture capital for the results displayed in Tables 1-4 is reported in Table 5.

[15] See Kortum and Lerner (1998).

Table 5: Long-run Impact of Venture Capital on (Un)Employment

	DUNEMP/DVC	*DUNEMP/DINVEARLY*	*DEMP/DVC*	*DEMP/DINVEARLY*
	Table 1	*Table 2*	*Table 3*	*Table 4*
Column 4	-0.46	-0.33	1.12	3.54
Column 5	-0.51	-1.27	1.16	4.33
Column 6	-0.43	-0.42	1.34	4.02

To understand what these results imply we can use an example. If we take the figure –0.46 from the table, this tells us that a one unit increase in venture capital (i.e. *DVC* = 1) will reduce the change in unemployment by 46 percent. If in the absence of the change in venture capital the unemployment rate would have increased by 10 percent for example (i.e. *DUNEMP* = 10), then with the one unit change in venture capital, the unemployment rate would increase only by 5 percent. Taking the example of Germany, which had an average change in the unemployment rate over the period studied of 0.17 percent and an average change in DVC of 0.1 units, we can calculate that a one standard deviation increase in the change in DVC (equal to 0.18) would have reduced the change in the unemployment rate by around 0.1 percent according to the –0.46 figure. While the figure of –1.27 in Column 3 would imply that a one standard deviation increase in *DINVEARLY* (equal to 0.06) would have reduced the change in the unemployment rate by 0.08 percent. We can conduct a similar exercise for employment, these suggest that an increase in *DVC* by one standard deviation would increase the change in the employment index by between 0.2 and 0.248. Similarly an increase in *DINVEARLY* by one standard deviation would increase the change in employment by between 0.21 and 0.24. It should be noted that these figures are not too different for *DV*C and *DINVEARLY*. One note of caution in interpreting these figures is that we are using 10 years of data to try and infer the long-run impact of venture capital on un (employment). This might be inadequate, but the figures identified here may be used as a rough guide.

IV. Conclusions

It is by now well established that flexible labor markets and stringent welfare states improve aggregate employment performance. However, by leaving out capital market variables, past empirical results might have missed other important institutional factors and might have overstated the impact and significance of some of the labor market variables due to an omitted variable bias. The ability of a country to encourage and sustain technological innovation by

entrepreneurial firms is one of the main sources of economic and employment growth. Economic intuition suggests that venture capitalists have to play a key role in this respect because they have especially in the US often been able to provide promising companies with adequate risk financing. Economists have so far paid relatively little attention to the possibility of a virtuous circle between a dynamic venture capital industry, a well functioning stock market and entrepreneurial firms which could be of major help in improving the situation on the labor market.

Two of the leading researchers on venture capital, Paul Gompers and Josh Lerner, have recently argued that it is a challenging empirical problem to demonstrate a causal relationship between the presence of venture capital investment and innovation or job growth.[16] This paper produces empirical evidence of such a link at the macroeconomic level. As far as we know, this paper identifies for the first time a significant positive impact of seed, startup and expansion venture capital investment on aggregate labor market performance within a coherent, dynamic econometric framework. This result is of particular importance considering the fact that direct policies to combat unemployment, e.g., by deregulating the labor market or by trimming welfare state activities, are notoriously difficult to implement in the political decision process, so that indirect alternative routes such as via fostering the venture capital market are urgently called for in continental Europe. However, these results should not be misinterpreted as constituting a justification for government subsidies to the venture capital industry or for government-run venture capital activities. Rather, the government should provide an institutional framework which is favorable to the development of a flourishing private venture capital industry, e.g., by capitalizing the pension system and by allowing pension funds to invest part of their assets in venture capital firms. Based on the US example, this should further spur the development of the venture capital market in continental Europe.[17] However, it is also important to keep in mind in this respect that it is not only the supply of venture capital which might restrict the total volume of investments, but possibly also the lack of suitable entrepreneurs with innovative ideas. The education system especially at the university level would be the primary lever to address such a scarcity of able human resources.

This paper investigates the real effects of venture capital investment on labor market performance on the macroeconomic level. Future research could possibly tackle this issue on a more disaggregate level. On an a priori basis it seems that venture capital investment affects

[16] See Gompers and Lerner (2001, p. 164).
[17] See Jeng and Wells (2000).

labor demand for qualified workers more than for unqualified workers. Hence, the positive effect of venture capital investment on labor market performance should be more pronounced for qualified workers alone than for the total labor market. Furthermore, one could compare directly on the firm level whether venture capital backed firms grow more in terms of employment than suitable control firms with almost identical initial conditions except for the difference that those control firms do not receive financial support and advice from a venture capitalist.[18]

Finally, the venture capital revolution could be another case for a robust correlation between financial factors and economic growth that is consistent with a leading role for finance. Historically, GDP and job growth as well as the opening up of economies, nowadays often called globalization, have usually been finance-led. The availability of superior and more sophisticated financial systems have in the past often been key factors in letting countries jump ahead in terms of economic development and in engaging in more cross-border trade and capital flows.[19] This is possibly a self-reinforcing process or virtuous circle. Financial development is typically blocked by incumbents who try to protect their quasi-rents. Anonymous financial markets do not respect the value of incumbency and treat entrants more favorably than financial markets based on relationships. However, when outside opportunities improve dramatically and when pressure from abroad increases via trade and capital flows, such a behavior of incumbents becomes more and more inefficient and thus self-defeating.[20] Hence, viewed from an interest-group perspective it is not surprising that the ongoing process of globalization goes hand in hand with a dramatic change in the way firms are financed and with a rising role of venture capital.

[18] Engel (2001) is a first attempt for such an approach. This microeconometric paper finds empirical results along our lines, namely that venture capital backed firms grow more in terms of employment in Germany.
[19] See Rousseau and Sylla (2001).
[20] See Rajan and Zingales (2001).

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Appendix

Table 1: Description of the labor market and capital market variables

Macroeconomic time series	
Unemployment rate (UNEMP)	OECD standardized unemployment rate. Source: OECD Main Economic Indicators.
Total employment (EMP)	Civilian or (if not available) total economy employment (employees and self employed, index with base year 1995). Source: OECD Main Economic Indicators.
Real gross domestic product (GDP)	Source: OECD Main Economic Indicators
Institutional labor market variables	
Benefit replacement ratio (RR1)	Average replacement rate over the first year of an unemployment spell. Source: Blanchard and Wolfers (1999), pp. 11 ff. and data appendix. Three realizations per country (for 1986-89, 1990-94 and 1995-99). Indicator displays more variability than RRATE.
Benefit duration (BENEFIT)	Duration of unemployment benefits (years, 4 years meaning indefinite). Source: Layard and Nickell (1997), pp. 11 ff., and complementary data delivered by S. Nickell.
Union coordination index (UNCORD)	Union co-ordination in wage bargaining. Index with 3 = high, 2 = middle, 1 = low. Source: Layard and Nickell (1997), Table 3, and complementary data delivered by S. Nickell.
Employment protection index (EMPRO)	Country ranking with 20 as the most strictly regulated. Source: Layard and Nickell (1997), p. 6, Table 2, and complementary data delivered by S. Nickell.
Tax wedge (WEDGE))	Total tax wedge (in %). Sum of the payroll tax rate, the income tax rate and the consumption tax rate. Average rates derived from national income and tax data. Source: Layard and Nickell (1997), p.4, Table 1, and complementary data delivered by S. Nickell.
Venture capital investment time series	
Venture capital investment (VC)	Seed, startup and expansion (both government and private sector funded) as per mil of average GDP. Source: Own calculations based on Asian Venture Capital Journal (2000), Baygan, Freudenberg (2000), European Venture Capital Association (2000), National Venture Capital Association (2000), Jeng, Wells (2000)
Early stage venture capital investment (INVEARLY)	Seed and startup (both government and private sector funded) as per mil of average GDP. Source: Own calculations based on Asian Venture Capital Journal (2000), Baygan, Freudenberg (2000), European Venture Capital Association (2000), National Venture Capital Association (2000), Jeng, Wells (2000)
Institutional capital market variables	
Creditor rights (CREDITRIGHT)	Index of the legal system's protection of creditors in case of a firm's liqidation or reorganization. Range: 0 to 4, 4 is the highest level of creditor protection. Source: La Porta et al. (1998), p. 1136, Table 4.